US00660108OB1

(12) **United States Patent**
Garg

(10) **Patent No.: US 6,601,080 B1**
(45) **Date of Patent: Jul. 29, 2003**

(54) **HYBRID REPRESENTATION SCHEME FOR FACTOR L IN SPARSE DIRECT MATRIX FACTORIZATION**

(75) Inventor: **Rajat P. Garg**, Sunnyvale, CA (US)

(73) Assignee: **Sun Microsystems, Inc.**, Santa Clara, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/510,911**

(22) Filed: **Feb. 23, 2000**

(51) **Int. Cl.**[7] **G06F 7/38**
(52) **U.S. Cl.** **708/502**; 708/490
(58) **Field of Search** 708/446, 607, 708/160, 200, 490, 520; 710/68; 707/101

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,107,452	A *	4/1992	Karmarkar et al.	708/607
5,490,278	A *	2/1996	Mochizuki	708/446
5,548,798	A *	8/1996	King	710/68
5,983,230	A *	11/1999	Gilbert et al.	707/101
6,397,236	B1 *	5/2002	Garg et al.	708/446
6,470,368	B1 *	10/2002	Garg et al.	708/446

OTHER PUBLICATIONS

Anshul Gupta, Highly Scalable Parallel Algorithms for Sparse Matrix Factorization, May 1997, IEEE Transactions on Parallel and Distributed Systems vol. 8 No. 5, p. 502–520.*

Groz et al., Processing Apparatus for Performing Preconditioning Process through Multilevel Block Incomplete Factorization, Jul. 25, 2002, U.S. patent application Publication No. US2002/0099748 A1.*

Heath et al.; "Parallel Algorithms for Sparse Linear Systems", Parallel Algorithms for Matrix Computations; Society for Industrial and Applied Mathematics by Gallivan, et al.; Copyright 1990; pp. 83–124.

* cited by examiner

Primary Examiner—Chuong Dinh Ngo
Assistant Examiner—Chat C. Do
(74) *Attorney, Agent, or Firm*—Park, Vaughan & Fleming LLP; Pavel I. Pogodin

(57) **ABSTRACT**

A system that efficiently performs a CMOD operation in solving a system of equations involving a sparse coefficient matrix by identifying supernodes in the sparse matrix. Each supernode comprises a set of contiguous columns having a substantially similar pattern of non-zero elements. The system performs a CMOD operation on each supernode, by determining a structure for the supernode, and computing a function of the structure. The system uses a one-dimensional trapezoidal representation for the supernode during the CMOD operation, if the result of the function is lower than a threshold value, and otherwise uses a two-dimensional rectangular representation for the supernode. The function of the structure of the supernode is a function of a number of computational operations involved in computing a lower-triangular sub-block portion of the supernode and a number of computational operations involved in computing a rectangular sub-block portion of the supernode.

18 Claims, 7 Drawing Sheets